



Atty. Dkt. No. 042627-0110

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

**Applicant:** Sachiko TOKUMURA et al.

**Title:** THERMO-EXPANSIVE  
MICROCAPSULE,  
PRODUCTION PROCESS OF  
EXPANDED PRODUCT AND  
EXPANDED PRODUCT  
THEREOF

**Appl. No.:** 10/539,064

**International Filing Date:** 12/24/2003

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**Examiner:** PENG, KUO LIANG

**Art Unit:** 1796

**Confirmation Number:** 4259

**DECLARATION UNDER 37 CFR 1.132**

Commissioner for Patents  
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I, Sachiko Tokumura, declare as follows:

1. I am one of the inventors of the above-captioned application.
2. The experiments described herein were conducted by myself or under my direct supervision and control.
3. The present specification contains the following statement at page 2 pointing out the drawbacks of the thermo-expansive microcapsules according to Shimazawa (US 6,235,394; PCT counterpart WO 99/43758): "the shell wall of the expanded microcapsules has properties of thermo-setting resin, i.e., poor elasticity and brittleness like glass, due to the crosslinking of the functional groups in the shell wall material during expanding with heat.

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For this reason, the microcapsules can, only be applied under limited conditions and thus to limited end uses."

4. The present specification contains the following statement at pages 3-4 pointing out the superior results provided by the present invention over Shimazawa: "the inventors found a production process for thermo-expansive microcapsules of the present invention, wherein a nitrile monomer, a monomer having a carboxyl group in its molecule, a monomer having an amide group in its molecule, and a monomer having a cyclic structure in its side chain are employed to produce thermo-expansive microcapsules having superior heat and solvent resistance and excellent expanding performance in broad temperature range in high temperature region, and applicable in foaming and molding thermoplastic resin and thermo-setting resin to be molded at 200° C or higher temperature."

5. The experiments were made to ascertain any superior results of our claimed invention over Shimazawa (US 6,235,394).

6. Details of the Experiments and the Results Thereof:

(1) Comparative Example A:

The experiment was made by employing the thermo-expansive microcapsules according to Example 1 of Shimazawa (US 6,235,394) (having a shell of a polymer composed of acrylonitrile, N,N-dimethylacrylamide, N-methylolacrylamide and methacrylic acid) instead of the thermo-expansive microcapsules according to Example 2 of the present application and otherwise repeating Example 8. The results are shown below.

	Rubber sheet	Rubber sheet surface	Specific gravity of foamed rubber sheet (g/cm <sup>3</sup> )
Example 8 of the present application	Not foamed	Good	0.45
Comparative Example A	Not foamed	Good	0.85

In Comparative Example A, a rubber sheet having a good condition was obtained by double roll kneading, but was not foamed by heating for heat pressing (a foamed rubber sheet had a high specific gravity). The thermo-expansive microcapsules employed in Comparative

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Example A are inferior as an elastic body, since the functional groups in the shell materials form a crosslinked structure when they are heated. The crosslinked structure formed by the functional groups by heating for kneading restricts foaming by heating for heat pressing. On the other hand, the thermo-expansive microcapsules according to the present application, in which the functional groups are not crosslinked by heating, remain elastic even after a first application of heat (heating for kneading) and can be foamed by a second application of heat (heating for heat pressing).

(2) Comparative Example B:

The experiment was made by employing the thermo-expansive microcapsules according to Example 1 of Shimazawa (US 6,235,394) (having a shell of a polymer composed of acrylonitrile, N,N-dimethylacrylamide, N-methylolacrylamide and methacrylic acid) instead of the thermo-expansive microcapsules according to Example 6 of the present application and otherwise repeating Example 10. The results are shown below.

	Injection temperature (°C)	Density (g/cm <sup>3</sup> )	Weight reduction (%)
Example 10 of the present application	190	0.71	21
	210	0.66	27
	230	0.67	26
	250	0.69	23
Comparative Example B	190	0.81	10
	210	0.80	11
	230	0.80	11
	250	0.83	8

Although Comparative Example B showed foaming at an elevated temperature, too, Example 10 of the present application achieved a greater degree of reduction in weight of the molded products. The examination in section of the molded products confirmed the introduction of spherical air bubbles by the capsules in Example 10, but revealed the presence of some broken capsules in Comparative Example B. This is believed to teach that the thermo-expansive microcapsules employed in Comparative Example B were so inferior as an elastic body that some capsules were broken by the injection pressure.

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7. I hereby declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements so made are punishable by fine or imprisonment, or both, under Section 101 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date September 19, 2008Sachiko Tokumura  
Sachiko Tokumura